Claims

1. (Currently amended) An airgun, comprising:

a compressed gas chamber;

a barrel;

a firing valve controlling gas flow between the compressed gas chamber and the barrel;

a secondary cylinder connected to the compressed gas chamber;

a secondary piston reciprocating within the secondary cylinder and dividing the secondary cylinder into a front volume connected to the compressed gas chamber and a back volume;

a ~~liquefied gas~~ fluid chamber connected to the back volume of the secondary cylinder;

a transfer valve for transferring a volume of ~~liquefied gas~~ fluid from a fluid source into the ~~liquefied gas~~ fluid chamber;

a cocking and firing mechanism capable of selectively opening and closing the firing valve to allow pressurized gas in the compressed gas chamber to be released and directed through the barrel, the mechanism also controlling the transfer valve to selectively transfer fluid from the fluid source to the fluid chamber

~~a cocking mechanism for closing the firing valve, and for at least one of i) filling the compressed gas chamber with a first gas at an elevated pressure, and ii) transferring a volume of a liquefied second gas into the liquefied gas chamber through the transfer valve; and~~

~~a firing mechanism for opening the firing valve~~.

2. (Currently amended) The airgun of Claim 1, wherein:

the compressed gas chamber comprises ambient air and the fluid source comprises carbon dioxide

~~upon cocking of the airgun, the compressed gas chamber is filled with the first gas at an elevated pressure, and the volume of liquefied second gas is transferred into the liquefied gas chamber;~~

~~upon cocking of the airgun, pressure exerted by the second gas in the back volume moves the secondary piston so as to reduce the front volume and further compress the first gas to about a saturation pressure of the second gas; and~~

~~upon firing of the airgun, the first gas flows through the firing valve into the barrel, and pressure exerted by the second gas in the back volume moves the secondary piston so as to reduce the front volume and maintain pressure of the first gas near the saturation pressure of the second gas during an initial portion of the flow of the first gas into the barrel~~.

3. (Currently amended) The airgun of Claim ~~2, wherein, upon firing of the airgun and during an intermediate portion of the flow of the first gas into the barrel, pressure exerted by the second gas in the back volume~~ 1, wherein the secondary piston is movable in response to pressure in the back volume to at least partially disengage from the second cylinder and to establish a fluid flow path between the back volume and the compressed gas chamber ~~moves the secondary piston so as to at least partially disengage the secondary piston from the secondary cylinder, thereby enabling the second gas to flow into the compressed gas chamber, through the firing valve, and into the barrel~~.

4. (Currently amended) The airgun of Claim 1, wherein:

~~upon cocking of the airgun, the compressed gas chamber is filled with a first gas at an elevated pressure; and~~

~~upon firing of the gun, the first gas flows~~ the compressed gas chamber and the front volume of the secondary cylinder are in fluid communication with each other.

5. (Currently amended) A method for using the airgun of Claim [[4]] 1, comprising:

cocking the airgun ~~of Claim 4~~, thereby closing the firing valve and filling the compressed gas chamber with ~~the~~ a first gas at an elevated pressure; and

firing the airgun ~~of Claim 4~~ by opening the firing valve, so that the first gas flows through the firing valve into the barrel.

6. (Original) The method of Claim 5, wherein the first gas is ambient air, and the first gas is compressed to between about 400 psig and about 600 psig in the compressed gas chamber.

7. (Currently amended) The airgun of Claim 1, wherein:

~~upon cocking of the airgun, the volume of liquefied second gas is transferred into the liquefied gas chamber;~~

~~upon cocking of the airgun,~~ wherein the secondary piston is movable in response to pressure exerted by ~~the second gas~~ fluid in the back volume ~~moves the secondary piston so as~~ to at least partially disengage the secondary piston from the secondary cylinder, thereby enabling the ~~second gas~~ fluid to flow into the compressed gas chamber~~; and~~

~~upon firing of the airgun, the second gas flows through the firing valve into the barrel~~.

8. (Currently amended) A method for using the airgun of Claim 7, comprising:

cocking the airgun ~~of Claim 7~~, thereby transferring ~~the~~ a volume of ~~liquefied second gas~~ fluid into the ~~liquefied gas~~ fluid chamber, therein pressure exerted by the ~~second gas~~ fluid in the back volume moves the secondary piston so as to at least partially disengage the secondary piston from the secondary cylinder, thereby enabling the second gas to flow into the compressed gas chamber; and

firing the airgun of ~~Claim 7~~ by opening the firing valve, so that the second gas flows through the firing valve into the barrel.

9. (Currently amended) The method of Claim 8, wherein the ~~second gas~~ fluid is carbon dioxide.

10. (Currently amended) The airgun of Claim 1, wherein the compressed gas chamber comprises a primary cylinder and a corresponding primary piston, and the cocking and firing mechanism moves the primary piston within the primary cylinder so as to compress ~~the~~ a first gas to ~~the~~ an elevated pressure within the compressed gas chamber.

11. (Currently amended) The airgun of Claim 10, wherein the cocking and firing mechanism includes:

a lever pivotably connected to the airgun; and

a mechanical linkage connecting the lever and the primary piston,

wherein pivoting of the lever results in movement of the primary piston within the primary cylinder.

12. (Original) The airgun of Claim 10, wherein a single stroke of the primary piston within the primary cylinder compresses the first gas to between about 400 psig and about 600 psig.

13. (Currently amended) The airgun of Claim 1, further comprising a ~~liquefied gas~~ fluid reservoir, wherein the ~~liquefied gas~~ fluid reservoir is connected to the ~~liquefied gas~~ fluid chamber through the transfer valve.

14. (Original) The airgun of Claim 1, further comprising a safety mechanism, wherein:
the safety mechanism must be disengaged for enabling cocking of the airgun; and
the safety mechanism must be re-engaged for enabling firing of the airgun.

15. (Original) The airgun of Claim 14, wherein disengaging the safety mechanism closes the firing valve.

16. (Currently amended) The airgun of Claim 14, wherein the safety mechanism must be disengaged to enable filling of the compressed gas chamber with ~~the~~ a first gas at an elevated pressure.

17. (Currently Amended) The airgun of Claim 14, wherein re-engaging the safety mechanism transfers the volume of ~~liquefied second gas~~ fluid into the ~~liquefied gas~~ fluid chamber.

18. (Original) The airgun of Claim 14, wherein the safety mechanism must be re-engaged to enable opening of the firing valve.

19. (Currently amended) The airgun of Claim 1, wherein the cocking and firing mechanism includes a lever pivotably connected to the airgun, and a mechanical linkage connected to the lever for closing the firing valve.

20. (Currently amended) The airgun of Claim 1, wherein the cocking and firing mechanism includes a lever pivotably connected to the airgun, and a mechanical linkage connected to the lever for actuating the transfer valve.

21. (Currently amended) The airgun of Claim 1, wherein ~~the~~ a first gas in the compressed gas chamber comprises ambient air.

22. (Currently Amended) The airgun of Claim 1, wherein the ~~second gas~~ fluid comprises carbon dioxide.

23. (Original) The airgun of Claim 1, wherein the transfer valve comprises a shuttle valve.

24. (Currently amended) The airgun of Claim 1, further comprising a passage for enabling gas to vent from the back volume during filling of the compressed gas chamber with the first gas and prior to transferring the volume of ~~liquefied second gas~~ fluid into the ~~liquefied gas~~ fluid chamber.

25. (Currently amended) The airgun of Claim 1, wherein:

~~upon cocking of the airgun,~~ the cocking and firing mechanism is actuatable to fill the compressed gas chamber ~~is filled with the first gas~~ with ambient air at an elevated pressure, and to cause the transfer valve to initiate transfer of the fluid into the fluid chamber.~~the volume of liquefied second gas is transferred into the liquefied gas chamber;~~

~~upon cocking of the airgun, pressure exerted by the second gas in the back volume moves the secondary piston so as to reduce the front volume and further compress the first gas to about a saturation pressure of the second gas;~~

~~upon firing of the airgun, the first gas flows through the firing valve into the barrel, and pressure exerted by the second gas in the back volume moves the secondary piston so as to reduce the front volume and maintain pressure of the first gas near the saturation pressure of the second gas during an initial portion of the flow of the first gas into the barrel;~~

~~upon firing of the airgun, during an intermediate portion of the flow of the first gas into the barrel, pressure exerted by the second gas in the back volume moves the secondary piston so as to at least partially disengage the secondary piston from the secondary cylinder, thereby enabling the second gas to flow into the compressed gas chamber, through the firing valve, and into the barrel;~~

~~the first gas comprises ambient air; and~~

~~the second gas comprises carbon dioxide.~~

26. (Currently amended) The airgun of Claim ~~25~~ 1, wherein:

the ~~elevated pressure of the first gas is~~ compressed gas chamber comprises ambient air at an initial pressure of between about 400 psig and about 600 psig;

the back volume comprises fluid that exerts a pressure on the secondary piston causing the ambient air in the compressed gas chamber to be compressed to a higher pressure in a range of about 700 psig to about 900 psig; and

a resulting airgun muzzle velocity ~~energy of the airgun remains~~ of a projectile fired through the barrel by the gas and the fluid expelled through the barrel is between about ~~12 ft-lb~~ 750 ft/s and about ~~14 ft-lb~~ 850 ft/s over a temperature range between about 45° F and about 85° F.

27. (Currently amended) The airgun of Claim 1, wherein:

the airgun further comprises a ~~liquefied gas~~ fluid reservoir connected to the ~~liquefied gas~~ fluid chamber through the transfer valve;

the transfer valve comprises a shuttle valve;

the compressed gas chamber comprises a primary cylinder and a corresponding primary piston;

the cocking and firing mechanism includes a first lever pivotably connected to the airgun and a mechanical linkage connecting the lever and the primary piston, and pivoting of the lever

results in movement of the primary piston within the primary cylinder, so that cocking of the airgun by pivoting the first lever results in movement of the primary piston within the primary cylinder so as to compress ~~the~~ a first gas within the compressed gas chamber;

the first lever includes a safety latch, wherein the safety latch must be disengaged for enabling pivoting of the first lever and cocking of the gun;

the cocking and firing mechanism includes a second lever pivotably connected to the airgun and mechanically linked to the safety latch so that disengaging and re-engaging the safety latch result in pivoting movement of the second lever;

the second lever is mechanically linked to the firing valve so that disengaging the safety latch closes the firing valve;

the second lever is mechanically linked to the firing valve so that the safety latch must be re-engaged to enable opening of the firing valve;

the second lever is mechanically linked to shuttle valve, so that disengaging the safety latch transfers the volume of ~~liquefied gas~~ fluid from the fluid reservoir and re-engaging the safety latch transfers the volume of ~~liquefied second gas~~ fluid into the ~~liquefied gas~~ fluid chamber; and

the airgun further comprises a passage for enabling gas to vent from the back volume during compression of the compressed gas in the compressed gas chamber and prior to transferring the volume of ~~liquefied second gas~~ fluid into the ~~liquefied gas~~ fluid chamber.

Claims 28-38 (Canceled)

39. (New) The airgun of Claim 1, wherein the secondary piston is movable in response to pressure in a direction causing the front volume to reduce in volume when a pressure in the back volume exceeds a pressure in the front volume.

40. (New) The airgun of Claim 1, wherein the front volume comprises compressed air at a first pressure, and the secondary piston is movable in response to pressure exerted by fluid in the back volume to cause the front volume to reduce in volume, thereby compressing the compressed air in the front volume to a second pressure higher than the first pressure.

41. (New) The airgun of claim 40, wherein the fluid in the back volume comprises carbon dioxide, and wherein the secondary piston is movable in response to pressure exerted by the carbon dioxide to compress a remaining portion of the compressed air in the front volume after the compressed air has begun to flow through the barrel when the firing valve is opened.

42. (New) An airgun propulsion system for propelling a projectile with a fluid under pressure, comprising:

a first chamber capable of holding a first charge comprising a first compressed fluid;

a second chamber capable of holding a second charge comprising a second compressed fluid;

a movable piston having a first side defining a boundary of the first chamber and a second side defining a boundary of the second chamber, the piston being movable between at least a first position at which the first charge remains separated from the second charge and a second position at which the second charge is vented from the second chamber to the first chamber to supplement the first charge in the first chamber; and

a valve positioned downstream of the first chamber and upstream of the projectile, the valve being selectively controllable to open and supply pressure from the first chamber to propel the projectile, and wherein when the movable piston is in the second position and the valve is opened, at least a portion of the first charge and at least a portion of the second charge are supplied through the valve to propel the projectile.

43. (New) The airgun propulsion system of claim 42 configured for use in a three-mode airgun:

wherein, in a first mode, the system is selectively controlled to propel the projectile with substantially only the first charge from the first chamber;

wherein in a second mode, the system is selectively controlled to propel the projectile with substantially only the second charge in the second chamber; and

wherein in a third mode, the system is selectively controlled to propel the projectile with at least a portion of the first charge and at least a portion of the second charge.

44. (New) The airgun of claim 2, wherein over a temperature range between about 45°F and about 85°F, the pressure exerted by carbon dioxide in the back volume on the secondary piston maintains the ambient air in the compressed gas chamber at a substantially constant pressure for at least an interval following opening of the firing valve, thereby maintaining a repeatable muzzle energy that varies less than about 10%.